CALIFORNIA DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-93

Aug. 14, 1979

1. Name of fault.

   Seal Cove and related faults.

2. Location of faults.

   Southwest corner of Montara Mountain 7.5-minute quadrangle and northwest corner of Half Moon Bay 7.5-minute quadrangle, San Mateo County (figure 1).

3. Reason for evaluation.

   Part of 10-year program to evaluate and revise Alquist-Priolo Special Studies Zones (SSZ) around existing active faults.

4. List of references.

Berlogar, Long & Associates, 1973, Supplemental geotechnical investigation, Moss Beach Rehabilitation Hospital Addition, Moss Beach, California: Consulting Report, 7 p.

__________, 1974, Engineering geologic investigation, Babkes Property, Montara, California: Consulting report for San Mateo County, 4 p.

__________, 1977, Geologic investigation, Portola Estates, Montara, California: Consulting report for San Mateo County, 7 p.

Brabb, E.E., and Pampeyan, E.H., 1972, Preliminary geologic map of San Mateo County, California: U.S. Geological Survey Basic Data Contribution 41, Map MF-328, scale 1:62,500.

Brown, R.D., Jr., 1972, Active faults, probable active faults, and associated fracture zones, San Mateo County, California: U.S. Geological Survey Basic Data Contribution 44, Map MF-355, scale 1:62,500.

Donley, Howard F. and Associates, 1974, Geotechnical investigation, Moss Beach Heights, Moss Beach, California: Consulting report for San Mateo County, 6 p.

Glen, William, 1959, Pliocene and lower Pleistocene of the western part of the San Francisco Peninsula: University of California Publications in Geological Sciences, v. 36, no. 2, p. 147-197, map scale approx. 1:44,000.

Jack, R.N., 1968, Quaternary sediments of the Montara Mountain area, San Mateo County: Uppublished M.A. thesis, University of California, Berkeley, map scale 1:10,000.

Jennings, C.W., 1975, Fault map of California, with locations of volcanoes, thermal springs, and thermal wells: California Geologic Data Map Series, Map No. 1, California Division of Mines and Geology, scale 1:750,000.

LaJoie, K.R., Weber, G.E., Mathieson, Scott, and Wallace, James, 1979, Quaternary tectonics of coastal Santa Cruz and San Mateo Counties, California, as indicated by deformed marine terraces and alluvial deposits, in Weber, G.E., LaJoie, K.R., and Grigg, G.B., editors, Coastal tectonics and coastal geologic hazards in Santa Cruz and San Mateo Counties, California: Field Trip Guide, Cordilleran Section of the Geological Society of America, 75th Annual Meeting, p. 61-80.

Leighton, F. Beach & Associates, 1971, Final engineering geologic report of the Seal Cove-Moss Beach area, County of San Mateo: Consulting report prepared for the County of San Mateo, 16 p.

__________________, 1974, Review and comment on geotechnical investigation, Moss Beach Heights Subdivision, Moss Beach, California: Consulting review for San Mateo County, 5 p.

Real, C.R., Parke, D.L., and Toppozada, T.R., 1978, Magnetic tape catalog of California earthquakes, 1900-1974: California Division of Mines and Geology, San Francisco Map Sheet area, scale 1:250,000.

State of California, 1974, Special Studies Zones, Montara Mountain and Half Moon Bay 7.5-minute quadrangles: California Division of Mines and Geology, scale 1:24,000.

Woodward - Ludgren & Associates, 1973, Preliminary geologic investigation, Farallone View School, Montara, California: Consulting report, 4 p.

Aerial photographs: Fairchild Aerial Surveys, 1941, Flight 3-23-41, C-6660-4 to 7, black and white, scale 1:24,000.

5. Summary of available data.

The Seal Cove fault zone is located approximately 32 kilometers southwest of San Francisco at the north end of Half Moon Bay (figure 1). The faults shown on the July 1, 1974 official maps of Special Studies Zones (State of California, 1974) include: (A) the northwest-trending Seal Cove fault zone in the southwesternmost corner of the Montara Mountain quadrangle near Seal Cove; and (B) two subsidiary northwest-trending zones to the

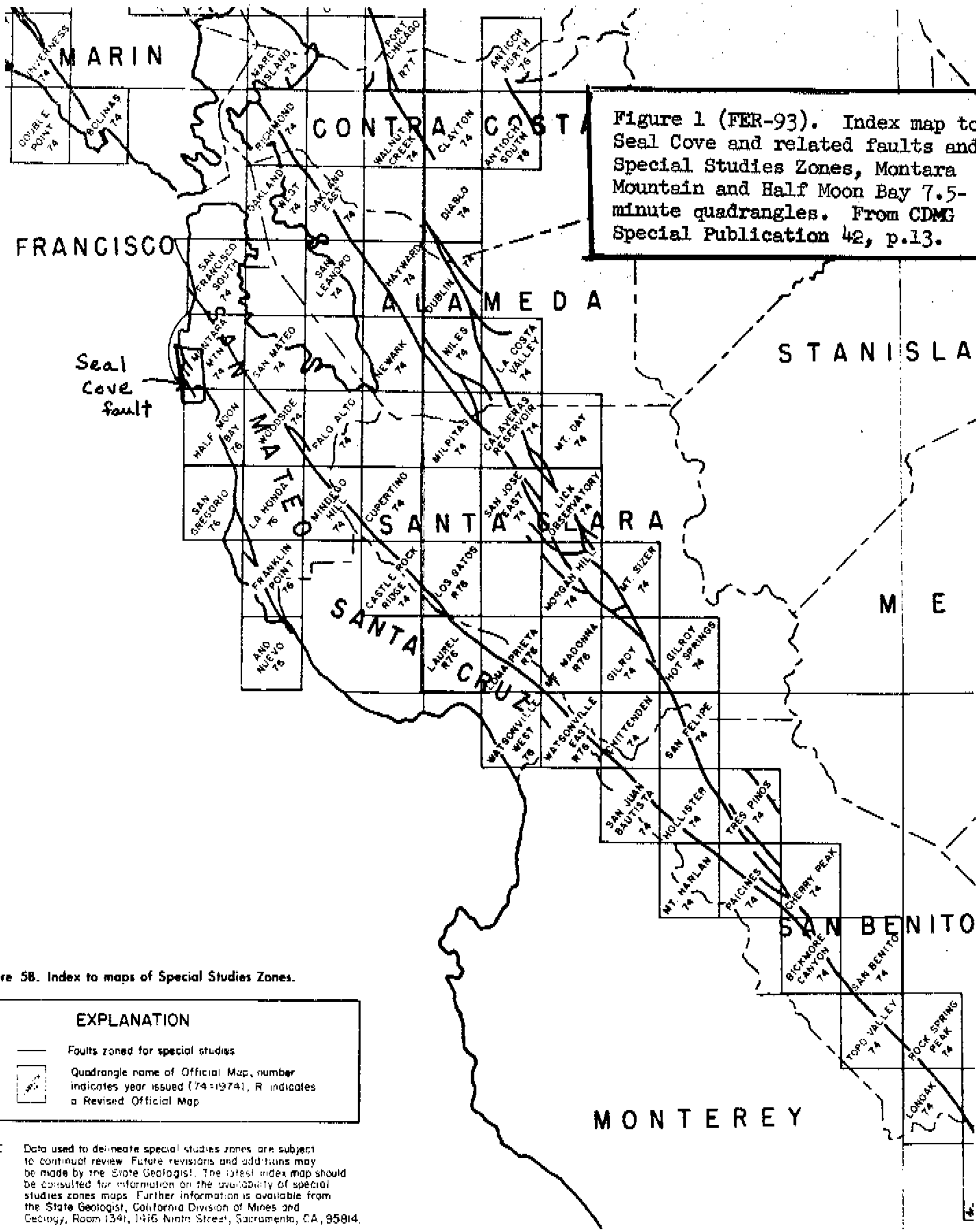

Figure 1 (FER-93). Index map to Seal Cove and related faults and Special Studies Zones, Montara Mountain and Half Moon Bay 7.5-minute quadrangles. From CDMG Special Publication 42, p.13.

Figure 58. Index to maps of Special Studies Zones.

EXPLANATION

Faults zoned for special studies

Quadrangle name of Official Map, number indicates year issued (74=1974), R indicates a Revised Official Map

NOTE Data used to delineate special studies zones are subject to continual review. Future revisions and additions may be made by the State Geologist. The latest index map should be consulted for information on the availability of special studies zones maps. Further information is available from the State Geologist, California Division of Mines and Geology, Room 1341, 1416 Ninth Street, Sacramento, CA, 95814.

Scale 1:1,000,000

1 inch equals approximately 16 miles

northeast of the Seal Cove fault between Moss Beach and Martini Creek (figure 2). The 1974 SSZ's were established on the basis of existing published data on Holocene and Quaternary faulting (Brabb and Pampeyan, 1972; Brown, 1972; and Leighton & Associates, 1971) and did not include aerial photo interpretation or field surveys of the zones by the California Division of Mines and Geology (CDMG).

A. Seal Cove fault.

The Seal Cove fault is expressed as a linear, northeast-facing scarp 15-45 meters high along the Half Moon Bay terrace north of Pillar Point (figure 2). According to LaJoie and others (1979), this 4-kilometer segment of the fault is part of a complex, major, seismically active zone that presumably branches from the San Andreas fault at Bolinas Lagoon and extends 190 kilometers south-southeast roughly parallel to the central California coastline to the Monterey area. The onshore scarp of the fault at Seal Cove extends 3 kilometers to the northwest of the shoreline on the ocean floor and 6 kilometers to the southeast across the floor of Half Moon Bay (LaJoie and others, 1979). The Seal Cove fault may connect with the San Gregorio fault zone south of Half Moon Bay.

Where it intersects the coastline at Moss Beach, the Seal Cove fault is exposed in a 15-meter high seacliff as a 37.5-meter-wide zone of intensely crushed and sheared rock. Late Pleistocene marine terrace deposits east of the fault are juxtaposed against Pliocene marine sandstones and shales of the Purisima Formation to the west of the fault. Upturned edges of the thin terrace deposits against the fault indicate that the Seal Cove fault is near-vertical and may have experienced both right-lateral and vertical displacement with the southwest side moving up (Glen, 1959; LaJoie and others, 1979). During low tides, evidence of deformation of the nearshore facies of the Purisima Formation is revealed along the beach just north of the fault trace where sandstones, siltstones, and pebble-boulder conglomerates have been drag folded against the fault (figure 3).

(1) Literature review of the Seal Cove fault.

The main trace of the Seal Cove fault was recognized by Berlogar, Long & Associates (1973), Brabb and Pampeyan (1972), Brown (1972), Glen (1959), Jack (1968), Jennings (1975), Leighton & Associates (1971), and Woodward-Lundgren & Associates (1973). Although there have been no earthquakes reported as having originated on the Seal Cove fault during historic time, the fault is generally considered (but not entirely documented) "active" by various authors on the basis of:

(a) Topographic expression of fault break and near coincidence with mapped bedrock fault (Brown, 1972);

(b) Offset marine terrace remnant near Moss Beach (Brown, 1972; Woodward-Lundgren & Associates, 1973);

(c) Displaced Holocene colluvium and slope wash (Leighton & Associates, 1971).

According to LaJoie and others (1979), gentle warps in the wave-cut terrace on both sides of the Seal Cove fault are interpreted as drag folds associated with right-lateral displacement along the fault over the past 100,000 years. LaJoie and others (1979) estimate that the current rate of movement across the Seal Cove fault may be between 0.6 and 1.0 centimeter per year. Quality A epicenter data collected for the San Francisco Bay area (Real and others, 1978) shows a paucity of epicenters in the vicinity of the Seal Cove fault (figure 4).

Although there is general agreement as to the location of the main trace of the Seal Cove fault, there is little or no agreement as to the identification and location of branch faults southwest of the main trace (figure 5). The three principal branch faults shown on the SSZ maps (State of California, 1974) originally were delineated by Leighton and Associates (1971) on the basis of subsurface geologic data (trenching) and detailed mapping of subtle topographic features (see annotations, figure 5). According to Leighton and Associates (1971), in the subsurface, the faults offset the terrace-bedrock contact and bring granitic basement rock into contact with the Purisima Formation. The two westernmost branch faults are detachment surfaces for ruptures associated with heads of landslides (Leighton and Associates, 1971). South of the town of Seal Cove, the traces of the faults, according to Leighton and Associates (1971), can be identified on the surf-cut bench as a wide crushed zone and in an exposure along the east side of Pillar Point where siltstones and shales are faulted against sandstones and siltstones of the Purisima Formation. The same discontinuous swales mapped as secondary fault traces by Leighton and Associates (area marked as "photo lineament" on figure 5) were interpreted by Glen (1959) as being part of a southeast-trending syncline.

(2) Aerial photo interpretation and field observations.

Analysis of 1941 (Fairchild) aerial photographs and field investigation of the Seal Cove fault zone indicate general agreement with existing maps in regard to location and recency of activity along the main trace of the Seal Cove fault (see annotations, figure 6). In contrast, observations of the recorded branch faults southwest of the main trace do not provide certainty as to the location or recency of activity along any of the mapped branch traces. Scarp features mapped as faults by Leighton & Associates (1971) in the vicinity of the town of Seal Cove, in my opinion, appear to be related to landsliding, terrace slumping and/or differential erosion of underlying earth materials rather than active faulting. However, the highly fractured nature of the bedrock, the highly errodible nature of softer overlying terrace deposits and soils, and the preponderance of landslides along fractures in the wave-cut cliffs make the abscence of Holocene fault activity virtually impossible to prove.

B. Subsidiary fault zone northeast of the Seal Cove fault.

At the time the 1974 SSZ maps were prepared, faults that displayed evidence of Quaternary (including Holocene) displacement were zoned. The two subsidiary fault zones northeast of the main trace of the Seal Cove fault were designated on the 1974 SSZ map (State of California, 1974; figure 2) on the basis that Quaternary terraces were supposedly offset (Brabb and Pampeyan, 1972); thus the faults were classified as being potentially active on the basis of Quaternary offset rather than on the basis of evidence of Holocene displacement, which is the criteria being used by CDMG in preparing current SSZ maps (E. Hart, personal communication, 1979).

Figure 3 (FER-93). Geology of the Fitzgerald Marine Reserve, showing syncline against the Seal Cove fault. Map modified from LaJoie and others (1979).

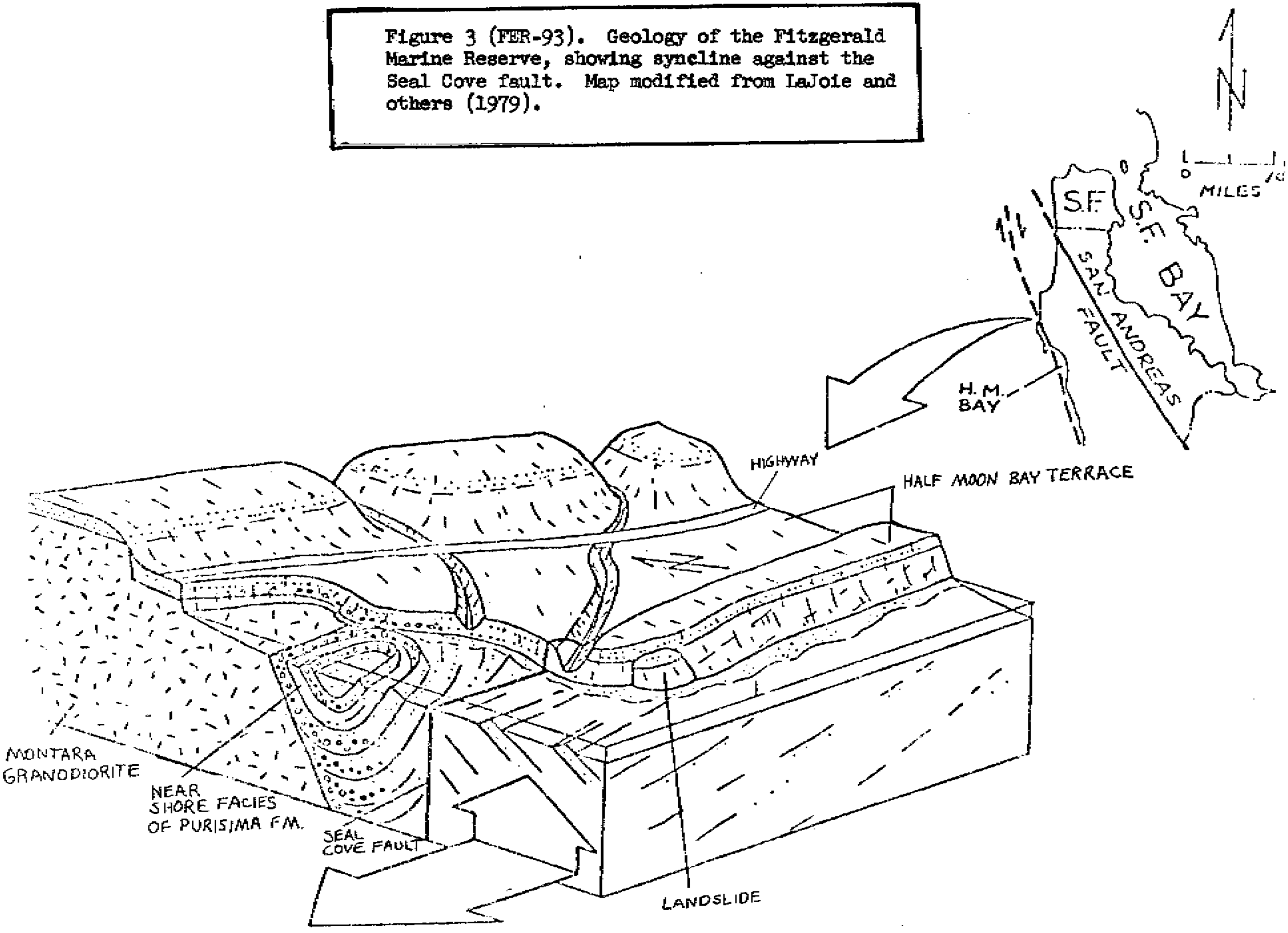

Figure 4

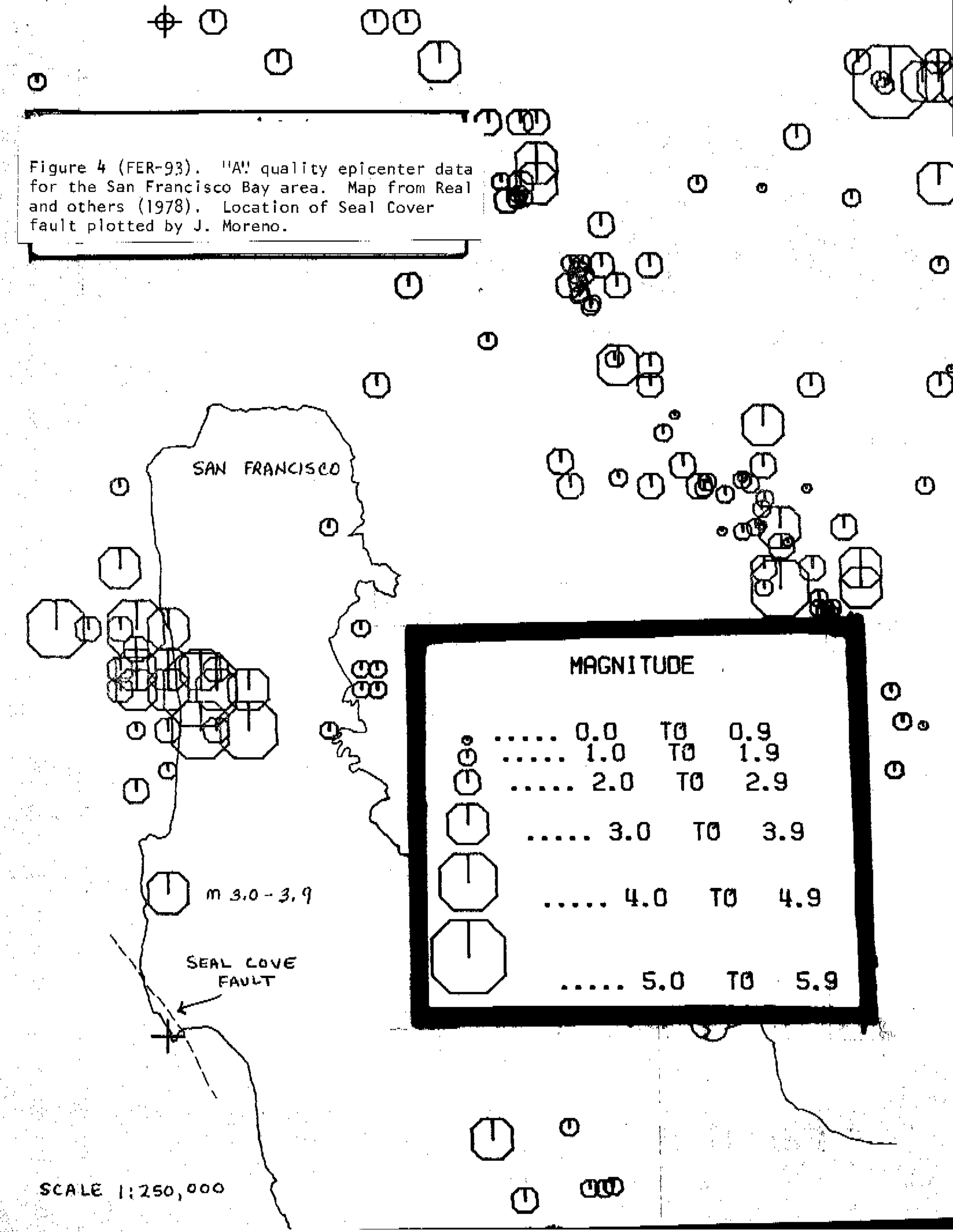

Figure 4 (FER-93). "A" quality epicenter data for the San Francisco Bay area. Map from Real and others (1978). Location of Seal Cover fault plotted by J. Moreno.

(1) Literature review of subsidiary fault zones.

The two subsidiary fault zones located northeast of the main trace of the Seal Cove fault (figure 2) were originally mapped by Jack (1968). On his map, Jack designated the locations of the faults with dashed lines indicating approximate, rather than well-located, traces. According to Jack (1968, p. 87-93), movement on these faults took place before or during the Montara episode of sedimentation, which took place during Pleistocene time (Jack, 1978, p. 82).

Although the two subsidiary fault zones are recognized on the preliminary geologic map of San Mateo County by Brabb and Pampeyan (1972), they do not appear on the "active fault" map compiled by Brown (1972). Consulting reports by Berlogar, Long & Associates (1973, 1974, 1977), Donley and Associates (1974), and Woodward - Lundgren and Associates (1973) do not consider the faults to be active.

Slightly different interpretations of the forked branches of the southernmost fault zone are presented by Jack (1968) and Brabb and Pampeyan (1972) (see figure 5). LaJoie and others (1979) suggest that recent tectonic movement may exist on a low (0.0 to 1.0-meter) scarp across the alluvial fan of Denniston Creek northeast of Highway 1. However, LaJoie and others (1979) do not present a map, and farming along the alluvial fan has obscured the exact location and extent of the scarp. Trenching by Berlogar, Long and Associates (1974) and Donley and Associates (1974) shows no evidence of recent faulting along or within the branches of the southernmost subsidiary SSZ (figure 5).

Consulting reports by Berlogar, Long & Associates (1977) indicate no evidence of recent faulting in trenches along the northeasternmost subsidiary SSZ (see annotations, figure 5). However, trenching just outside of the SSZ, directly east of Montara and east of the SSZ, exposed a fault that is considered "potentially active" by Berlogar, Long & Associates (1977; H. Minch, personal communication, 1979). The trench log (Trench 1, Berlogar, Long & Associates, 1977) depicts two "splinter" faults offsetting dikes in highly weathered Montara granodiorite. The faults do not, however, offset the overlying sandy silt deposits and, thus, should not be interpreted as being active.

(2) Aerial photo interpretations and field observations.

Analysis of 1941 (Fairchild) aerial photographs and field investigations of the subsidiary fault zones are summarized on figure 6. Although numerous faults are exposed in the cliffs along and south of Montara Beach, the faults occur primarily in bedrock, do not displace colluvial and/or alluvial deposits, and cannot be traced for extended distances in the field.

6. Conclusions.

A. Seal Cove fault. The location of the main trace of the Seal Cove fault is well-defined by its steep, high, linear, northeast-facing terrace scarp and by a sea cliff exposure of the fault along the scarp trend where it intersects the coastline at Moss Beach. The scarp is typical of strike-slip faults with an east-side up component. Probable Holocene activity along the fault is inferred by: (1) the high, steep scarp morphology; (2) subtle topographic features such as offset drainages and side-hill benches; (3) ponding along the toe of the scarp; (4) soil filled cracks in trenches (Leighton & Associates, 1971); and (5) rates of marine terrace displacements calculated by LaJoie and others (1979).

B. Two subsidiary faults zoned northeast of the Seal Cove fault. There is no evidence for Holocene faulting along the two subsidiary faults designated on the 1974 SSZ map northeast of the main trace of the Seal Cove fault. Farming on the alluvial fan northeast of the Half Moon Bay Airport has obscured any evidence of recent activity that may have taken place along the southwesternmost branch fault in the vicinity of Denniston Creek.

7. Recommendations.

A. Seal Cove fault: Retain existing main trace and SSZ, using the same references used in 1974.

B. Two subsidiary faults northeast of the Seal Cove fault: Delete existing SSZ and fault traces.

8. Report prepared on August 14, 1979, by:

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Geologist, RG 3363
San Francisco District Office

I agree with recommendations.
EWH
3/18/80

Figure 2

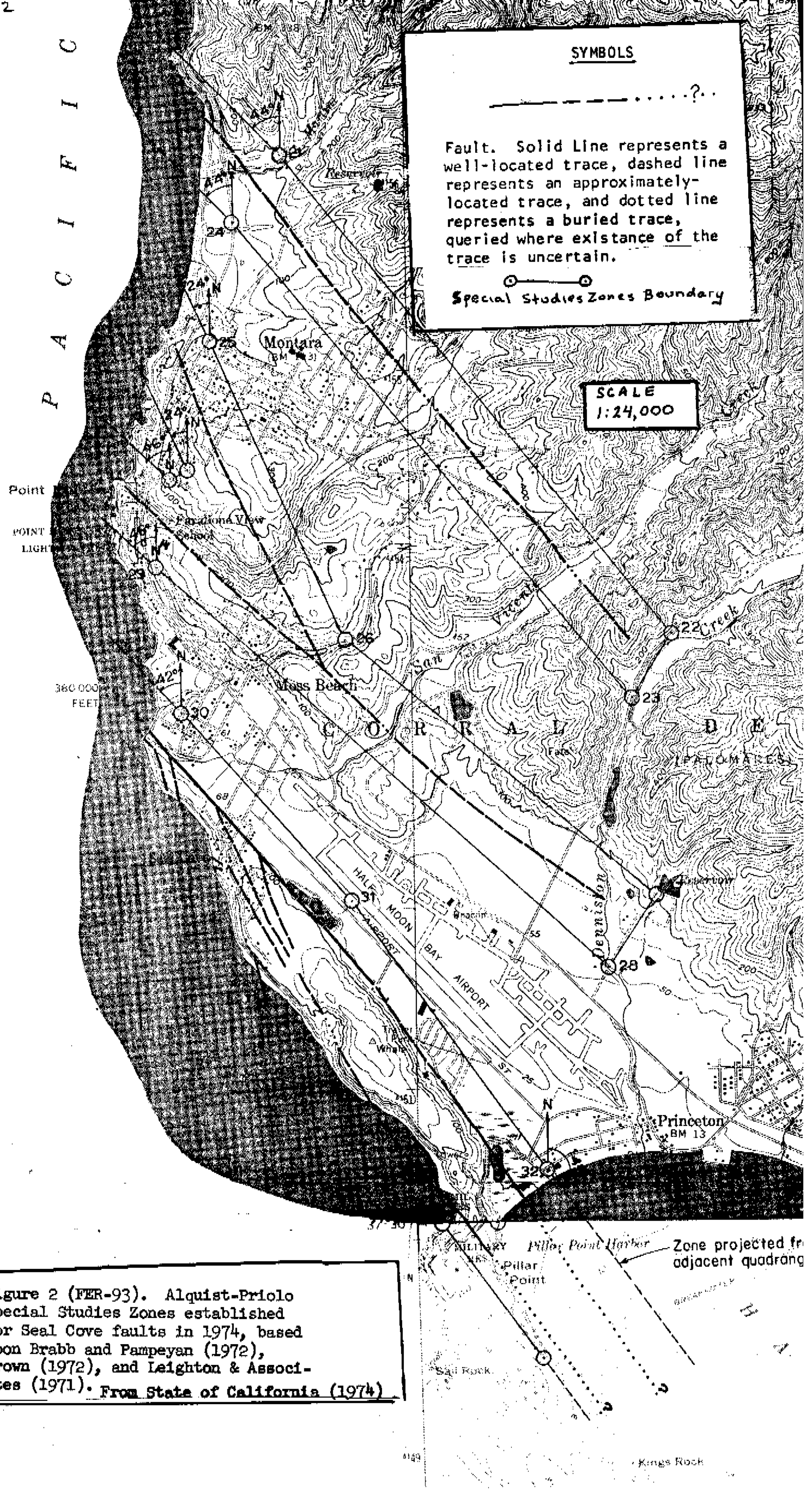


Figure 2 (FER-93). Alquist-Priolo Special Studies Zones established for Seal Cove faults in 1974, based upon Brabb and Pampeyan (1972), Brown (1972), and Leighton & Associates (1971). From State of California (1974)

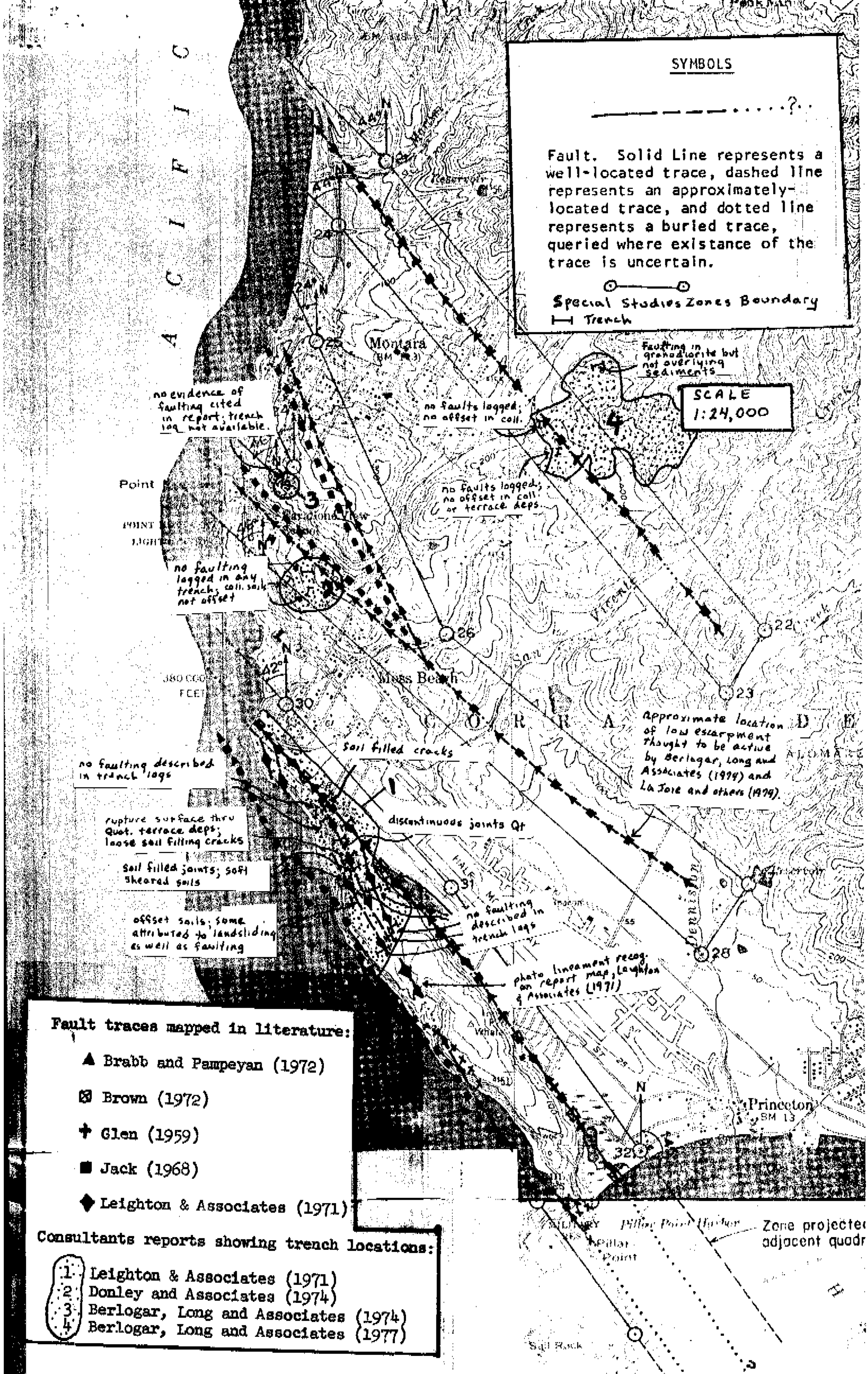
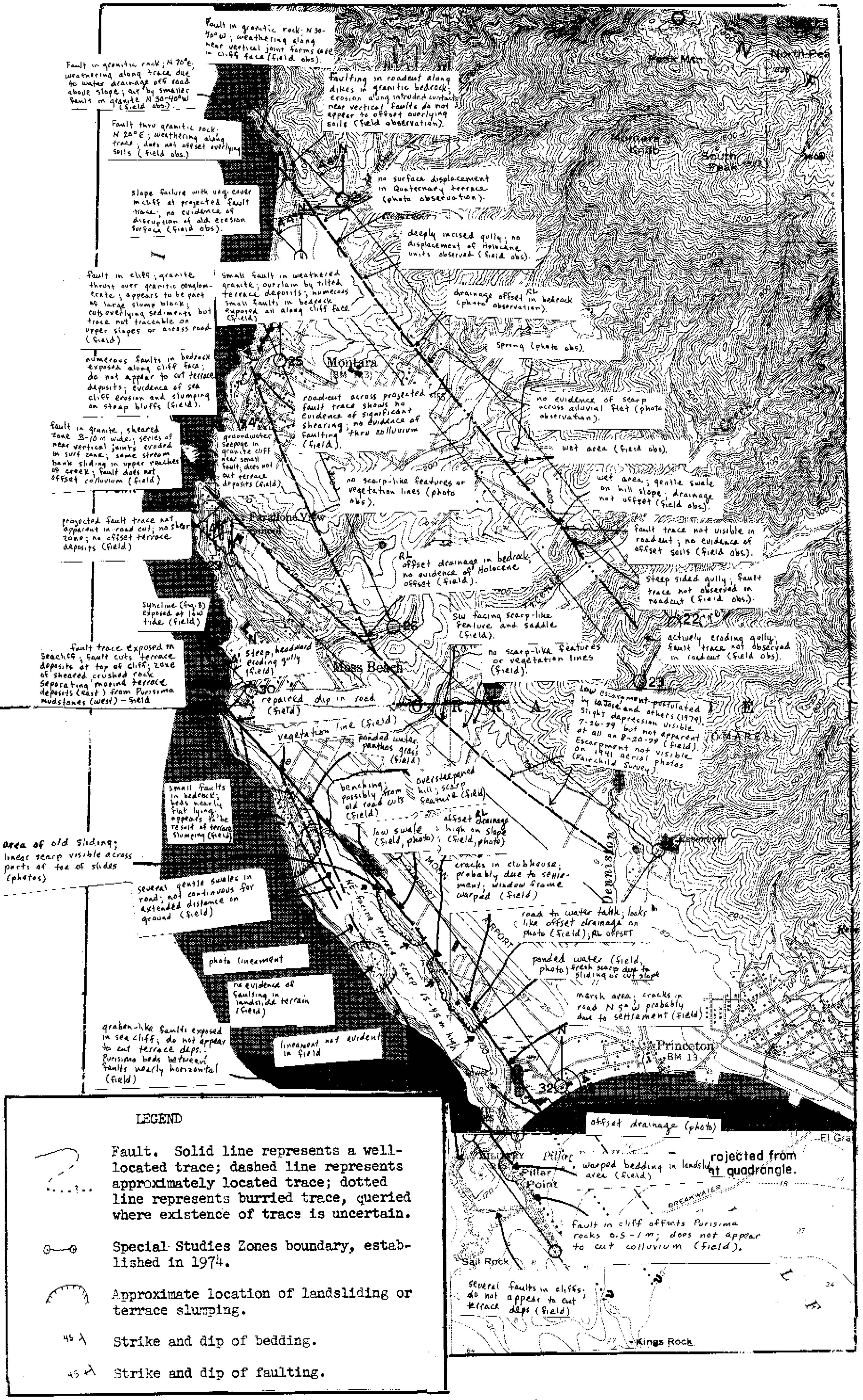


Figure 5 (FER-93). Location of trenches cited in consultants' reports and summary of literaure review. Base map from State of California (1974).

Figure 6 (FER-93). Summary of aerial photo interpreatation and field observations for Seal Cove faults. Plotted on SSZ base map (State of California, 1974).*



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Comments and annotations by
Trinda L. Bedrossian

* All aerial photo interpretations from Fairchild Collection, 1941.